Integrated MSc Petroleum Courses at Imperial College

Howard D. Johnson

MSc Petroleum Courses Director
&
Shell Professor of Petroleum Geology

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Presentation outline

1. Review the Petroleum MSc courses at Imperial College
2. Highlight course and subject integration
3. Review group projects: mechanism for integration
4. Conclusions

Integrated Upstream Petroleum Industry

**Technical Capability (People)
= Competitive Edge
(increased E&P complexity)**

Strategic Aims

- Develop multi-skilled geoscientists, geophysicists and engineers for the modern petroleum industry: rocks, fluids & technologies
- Integrate the three core disciplines: geology, geophysics & petroleum engineering:
 - Develop specialist skills in core subjects
 - Provide competence in allied subjects
- Reflect (changing) industry structure, workflows and methodologies
- Provide students with a framework for pursuing future professional careers
- Provide the international petroleum industry with technically-competent, well-trained and motivated graduate recruits

Integrated Petroleum Masters Courses

		Common	Geoscience	Geophysics	Engineering
Term 1	October	<div>Wessex Basin Field Trip</div> <div>Petrophysics ++</div> <div>Wytch Farm Project (x1)</div>	<div>PRODUCTION Development Geology Seismic Methods Petrol. Engineering</div>	<div>BASICS Petroleum Geology Pet. Engineering Seismic Methods</div>	<div>STATIC MODELS Fundamentals Reservoir Characterisation</div>
Term 2	January	<div>Group Projects (x3)</div>	<div>EXPLORATION Sequence Stratigraphy Petroleum Systems 3D Seismic Basin Analysis Barrel Award Project</div>	<div>Examinations</div> <div>DETAILS Advanced Methods Petroleum Geology Non-Seismic Methods Res. Characterisation Group Project</div>	<div>Examinations</div> <div>DYNAMIC MODELS Reservoir Simulation Production Facilities Production Economics Wytch Farm Project</div>
			<div>Utah field trip</div>		
Term 3	April	<div>Examinations</div>	<div>Examinations</div>	<div>Examinations</div> <div>Colorado Field Camp</div>	<div>Examinations</div> <div>International Field Trip</div>
Summer	July	<div>Independent Project</div> <div>Final Presentation</div>	<div>Independent Project</div> <div>Final Presentation</div>	<div>Independent Project</div> <div>Final Presentation</div>	<div>Independent Project</div> <div>Final Presentation</div>

Integration of the MSc Petroleum Courses

1. Petroleum Geoscience

2. Petroleum Geophysics

Geophysics Field Camp

3. Petroleum Engineering

MSc Integration:

- Dominated by reservoirs, rock properties & fluids
- Learnt in Group Projects:
 - Field Development Project (Term 1)
 - Barrel Award Project (Term 2)

‘E&P’
is taught as
‘P&E’

MSc Petroleum Geoscience, Geophysics & Engineering

Students: all need the fundamentals & integration

MSc Petroleum Geoscience: 50
MSc Petroleum Geophysics: 30
MSc Petroleum Engineering: 50
Total = 130

Bridport Sands at West Bay, Wessex Basin (October 2011)

Term 1: Production

Term 1: Production

Term 1: Production

Production: Field Development Group Project

Term 1: Field Development Group Project

Timing: 3 weeks (end of Term 1)

1. The three MSc classes are divided into **integrated geoscience, geophysics & engineering teams** (6-7 students per team)
2. **Aims:** evaluate the appraisal & initial development planning of the Sherwood Sandstone reservoir, Wytch Farm Field (Wessex Basin)
3. **Main deliverables:**
 - seismic interpretation & T-Z structure maps
 - stratigraphic zonation & depositional model
 - formation evaluation & petrophysics
 - reservoir geological model
 - fluid properties & fluid contacts
 - well test analysis
 - STOIIP and reserves estimates (including uncertainty)
4. Teams deliver **oral presentations & written reports**

Emphasis is on reservoir characterisation & field development planning

Term 1: Field Development Group Project – The Wytch Farm Oil Field

Location Map (www.googlemaps.com)

- Southern England
- Analysis of the Sherwood Sandstone reservoir
- Environmentally sensitive area

(www.portalwoodgroup.com)

Wessex Basin Field Trip at the start of Term 1: Outcrop analogues

All students collect outcrop
analogue data for later use in
constructing the Wyth Farm
Reservoir Model

Mercia Mudstone
(seal)

? ----- ?

Sherwood Sandstone
(reservoir)

Seismic Interpretation

A 3D visualization of a geological model, likely a subsurface structure. The model is elongated and complex, colored in yellow and black, representing different geological units. The axes are labeled: X-axis, Y-axis, and Z-axis. The Z-axis ranges from -2000 to 400000. The Y-axis ranges from 88000 to 392000. The X-axis ranges from 408000 to 412000. A scale bar indicates 5 Km. A legend on the left shows three categories: Black, Yellow, and Cyan, corresponding to different geological units.

3D visualization of the 1992 Mw=7.3 earthquake rupture surface. The plot shows the rupture surface as a yellow and black elongated shape within a 3D coordinate system. The X-axis ranges from 392000 to 412000, the Y-axis from 80000 to 88000, and the Z-axis from -2000 to 2000. A red arrow points to the rupture surface. A scale bar indicates 5 Km.

Multi storey Channels

3D Static Reservoir Geological Model

	Av. N/G from Logs	Model N/G	Comments
Transitional from fluvial to lacustrine	0.36	0.30	Poorly connected sandstones
Shale Layer	0.00	0.00	Impermeable barrier
Single storey fluvial channels	0.46	0.45	Moderately well connected sandstones
Braided channel belt	0.87	0.85	Well connected sandstones
Shale Layer	0.00	0.00	Impermeable barrier
Single storey fluvial channels	0.64	0.50	Petro-physical analysis of zone 6 showed a much lower N/G, so the model value was adjusted to reflect this.

Field Development Project: Summary

Highlights:

- Closely mimics FDP work within the petroleum industry during the appraisal/early development stage
- Intellectually demanding (cross-disciplinary work)
- All team members involved in the final project presentation
- Strict deadlines (3 weeks)

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Learning outcomes:

- Link outcrop and subsurface observations and interpretations
- Integrate geoscience and engineering thinking and problem solving
- Intellectual effort that goes into a 3D reservoir geological model
- Relationship between the static and dynamic models
- Development planning decisions guided by the model results
- Risk and uncertainties associated with model predictions

Term 2: Exploration

High-Grade Acreage & Drillable Prospects

Phase 2: Prospects

Prospect level understanding
prospect segmentation/
shotpoint risk ('surgical
mapping')

Phase 1: Basins

Fundamental
basin/play level &
regional understanding
(‘forensic
geoscience’)

Exploration: Barrel Award Group Project

Barrel Award Overview

- To document the tectono-stratigraphic evolution of a sedimentary basin
- To analyse the hydrocarbon prospectivity of c.10 datasets from sedimentary basins in contrasting structural and stratigraphic settings:
 - regional to sub-regional 2D or 3D seismic dataset
 - 1-5 wells with wireline data
- The analysis is undertaken by 10 teams of 5 students per team:
 - ca. 4 weeks evaluation time
- The project integrates all formal teaching from both Terms 1 and 2 ranging from Seismic Interpretation to Reservoir Characterisation, and from Basin Analysis to Source Rock Evaluation

Emphasis is on basin analysis & exploration/prospect evaluation

Exploration Risk and Uncertainty Analysis

Play Chance

- Define the stratigraphic framework:
 - Gross depositional environments
 - Sequence stratigraphy & stratigraphic evolution
- Define the regional tectonic framework
 - Plate tectonic setting
 - Basin type & evolution
- Define the petroleum systems & source rocks:
 - Nature and distribution of source rocks (depositional environments)
 - SR type and quality
 - Regional burial history & heat flow
- Reservoir
 - Depositional environment, thickness & distribution
 - Porosity/permeability & res. quality effectiveness
- Seal:
 - thickness, quality, effectiveness & extent
- Basin modelling:
 - timing of migration & hydrocarbon types
 - migration pathways, etc.
- Synthesise regional HC distribution
 - Reservoir/source/seal maps
 - Common Risk Segment (CRS) mapping

Prospect Specific Chance

- Trap definition and integrity
 - Trap origin & evolution
 - Structural & stratigraphic elements
 - Nature of reservoir prone intervals
- Trap charge and preservation
 - Define critical trapping elements & effectiveness of sealing mechanisms, e.g.:
 - Fault geometry
 - Cross fault juxtaposition vs. fault membrane/capillarity
 - Trap validity
 - Supportable HC column height
 - Number of stacked sands
- Analogues/controls
 - Fields within your database/study area
 - Other analogous fields: e.g. trap/reservoir/fluids
- Risk mitigation
 - Critically evaluate geometric validity of trap interpretation
 - Identify possible leakage points
 - Estimate HC column heights supported
 - Assess number of multiple stacked pays

To be assessed using each team's data and understanding

Play synthesis – Lower Congo Basin

Post-Salt Migration		Malembo Turbidites		Pinda Carbonates
Pre-Salt Migration		Chela Sandstones		Lucula Sandstones

Barrel Award Project: Summary

Highlights:

- Closely mimics play and prospect evaluation work within the petroleum industry during the exploration stage
- Integrates Applied Sedimentology, Basin Analysis and Petroleum Systems Analysis course (demonstrates the linkages in Term 2 teaching)
- All team members involved in the final project presentation
- Strict deadlines (4 weeks)

Barrel Award Project: Summary

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- Closely mimics play and prospect evaluation work within the petroleum industry during the exploration stage
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Learning outcomes:

- Applying the 'exploration triangle': "geology from the bottom-up"
- Integrate basin and exploration thinking and problem solving
- Reconstruct basin evolution and the response of fluid migration
- Play and prospect risks and uncertainties
- Exploration planning decisions guided by the basin model results

Conclusions

1. Petroleum MSc courses at Imperial College involve integration of Geoscience, Geophysics and Petroleum Engineering: subject matter and students!
2. 'E&P' is taught as 'P&E' because this lends itself to teaching rock and fluid fundamentals and subsurface tools to all MSc students
3. Group projects represent large practical exercises that integrate all previously taught material within established E&P workflows
4. Group projects are successful for the following reasons:
 - Student ('guided') independence & team ownership
 - High degree of critical analysis & creative thinking
 - Presenting results to industry panels adds realism
 - High sense of achievement & satisfaction

100 Years and Beyond:

Future Petroleum Science & Technology Drivers

Date: 23-24 September 2013

Venue: Imperial College London

This 2-day meeting will celebrate 100 years of petroleum-related science and engineering education at Imperial College. With a list of distinguished speakers, we aim to mark this landmark achievement by looking forward to the next 100 years, with emphasis on discussing key future drivers and related energy supply issues. The meeting will be wide-ranging, with presentations covering global energy trends, future geoscience and engineering technologies, unconventional hydrocarbon resources, carbon sequestration and climate change.

We have an outstanding group of confirmed speakers, including:

- Lord Ron Oxburgh
- Lord John Browne
- Professor Scott Tinker (Director, Bureau of Economic Geology, Texas)
- Dr. Bruce Levell (VP Emerging Technologies, Shell)
- Malcolm Brown (Senior VP Exploration, BG Group)
- Bryan Lovell (former President, Geological Society of London)
- Professor Joe Cartwright (University of Oxford)
- Emeritus Professor John Woods (Imperial College & the 2007 Joint Nobel Peace Prize Winner)
- Mike Daly (VP Exploration, BP)

Further information and registration details:

Further information and registration details can be found at:
www.geolsoc.org.uk/oilcentenary13

or contact Steve Whalley at the Geological Society, using the following email address: steve.whalley@geolsoc.org.uk

The meeting is jointly convened by Imperial College London and by The Geological Society of London, supported by the American Association of Petroleum Geologists, The Society of Petroleum Engineers and by the Petroleum Exploration Society of Great Britain and the European Association of Geoscientists and Engineers.

IN ASSOCIATION WITH

PES GB

Celebrating 100 years of Oil Technology Education at Imperial College

(23-24 September 2013)

Selected speakers:

- Lord Oxburgh: former Rector of IC
- Lord Browne: former CEO, BP
- Scott Tinker: Director, BEG, Texas
- Ed Daniels: Chairman, Shell UK
- Bruce Levell: Shell Chief Scientist Geology
- Malcolm Brown: VP Exploration, BG Group
- Tony Doré, OBE: VP Exploration, Statoil
- Mike Daly: VP Exploration, BP
- Dominique Marion: VP Production, Total
- Tristan Aspray: Manager, ExxonMobil